COMPOSITE CONSTRUCTIONAL ELEMENT AND METHOD OF MANUFACTURING A COMPOSITE CONSTRUCTIONAL ELEMENT

TECHNICAL FIELD

A composite constructional element and a method of manufacturing such an element are disclosed. The constructional element is particularly suitable for constructing a wall, floor or roof.

BACKGROUND ART

Building systems in the form of prefabricated modular building systems have a tendency to rely upon heavy machinery for their construction, are generally labour intensive and may require many different tradespersons for construction. Although such systems may be modular, they may require the separate construction and application of external and internal finishes. An example of components of a prefabricated modular building system is aluminium cladding. Such cladding may be positioned and fixedly located on the exterior of a fibre panel or wood panel building structure.

WO02/35026 discloses a constructional element including a structural member in the form of a hollow steel box section and cladding formed about at least part of the structural member. The cladding is formed of a cement based material such as fibre cement. The cladding is moulded around the structural member and includes an abutment means in the form of a protrusion along one edge and a mating channel along the other edge, so that adjacent constructional elements can be aligned. The constructional elements are fixed at their ends to support elements. The system of WO02/35026 has the advantage that

the cladding material can be provided with a number of different finishes. However, the moulding of the cladding can require a somewhat complex moulding procedure.

SUMMARY OF THE DISCLOSURE

In a first aspect a composite constructional element is provided that comprises:

a plank profile defining a rear face and two opposed edge sections of the constructional element, each edge section including an edge face; and

a cladding material moulded into the plank profile to extend continuously between the opposed edge faces such that it is retained by the rear face and the opposed edge faces.

In a second aspect a composite constructional element is provided that comprises:

a plank profile defining a rear face and two opposed edge sections of the constructional element, each edge section including an edge face; and

a cladding material moulded into the plank profile such that it is retained by the rear face and the opposed edge faces;

wherein the plank profile further comprises at least one retaining formation shaped to retain the moulded cladding material attached to the plank profile.

In a third aspect a method of manufacturing a composite constructional element comprises the steps of:

providing a plank profile comprising a rear face and two opposed edge sections, each edge section including an edge face; and

moulding a cladding material into the plank profile such that it extends continuously between the opposed edge

faces and is retained by the rear face and the opposed edge faces.

In a fourth aspect a method of manufacturing a composite constructional element comprises the steps of:

providing a plank profile comprising a rear face and two opposed edge sections, each edge section including an edge face, the plank profile further comprising at least one retaining formation; and

moulding a cladding material into the plank profile such that it moulds into the retaining formation to attach to the plank profile and is retained by the rear face and the opposed edge faces.

The cladding material is thus moulded into the plank profile so that the profile itself forms the mould. In addition, there is no requirement for a separate step of moulding the cladding material around a structural member. Further, by extending the cladding material continuously between the opposed edge faces a constructional element having a unitary appearance can be achieved.

The cladding material can thus form substantially an entire front face of the constructional element, which may be substantially flat. Thus, there can be little or no part of the plank profile visible when the constructional elements are assembled, for instance, to form a wall.

The resulting composite constructional element may also be made thinner and lighter than prior art constructional elements. The cladding material may be provided with a number of different finishes to resemble masonry.

The retaining formations can be defined (eg. formed) as part of the plank profile and therefore can define part of the mould for the cladding material and be shaped to

retain the cladding material attached to the plank profile. The cladding material can thus be moulded into or around the retaining formations. The retaining formations can provide the main means by which the cladding material is attached to the plank profile, and can allow for differential thermal expansion between the cladding and plank materials.

For example, retaining formations may be formed adjacent to or as part of the edge sections. Then, if there are differences in the expansion or contraction of the plank and cladding materials with changes in temperature, the plank and the cladding material can bow such that they can separate slightly in the centre but yet be retained attached at the edges. This can prevent cracking of the cladding material.

Each retaining formation may comprise longitudinal channels of substantially uniform cross section and filled with cladding material, and being shaped in cross section to retain the moulded cladding material attached to the plank profile. In this regard, each channel cross-section may be defined as a type of undercut or underhook.

Each edge section may include an attachment formation for attachment to a mating attachment formation on an adjacent constructional element.

In one embodiment the attachment formation can comprise a frontwardly facing channel formed along one edge section and a rearwardly projecting lip formed on the opposed edge section, wherein the lip is capable of clipping into or being retained at a frontwardly facing channel of an adjacent constructional element.

In this embodiment the lip can include a recess such that, when clipped into or retained at a mating channel on

an adjacent constructional element, a recess is defined between a base of the mating channel and the lip. This allows for the head of a fastening means such as a hex-headed screw to be accommodated in the recess when the lip is engaged in the channel. Such a fastening means may be used to first fasten the adjacent constructional element to a building element through the base of the channel. Then, when a next constructional element is clipped into position, the fastening means can be hidden from view.

The frontwardly facing channel may project outwards beyond one edge face, and the lip may be formed inwards from the opposed edge face. Further, the lip may comprise one of the retaining formations.

In another embodiment, the channel is formed as a separate piece and can include a depending portion which can extend over the adjacent edge face and be embedded in the cladding material once the composite constructional element is formed. Alternatively, the plank profile, including the rear face, the edge sections and the attachment formations, may be integrally formed from a sheet material.

Optimally the plank profile can be formed from sheet steel, such as by roll-forming. This is a particularly simple and effective manufacturing method for forming such profiles.

The plank profile may include at least one longitudinal stiffening formation comprising a ridge. This is particularly useful when each constructional element is used to form a load bearing structure such as a floor. The or each ridge can be formed as a channel in the plank profile which can then be filled with cladding material.

The cladding material may comprise cement, concrete, fibre cement, fibreglass, cellulose, foamed polymeric material, ceramics or polystyrene, but glass reinforced cement is a material typically employed to give a stone-type finish that is also lightweight.

BRIEF DESCRIPTION OF THE DRAWINGS

Notwithstanding any other forms which may fall within the scope of the composite constructional element as defined in the Summary, specific embodiments of the composite constructional element will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a side perspective view showing a plurality of interconnected constructional elements according to a first embodiment;

Figure 2 is a side perspective view illustrating a plurality of interconnected constructional elements of the first embodiment of the invention forming a corner;

Figure 3 is an elevated perspective view of a join between ends of constructional elements of the first embodiment;

Figure 4 is an exploded section in perspective of a constructional element of the first embodiment and a sealing element;

Figure 5 is a side perspective view of a plank profile for a constructional element according to a second embodiment;

Figure 6 is an exploded perspective view of a constructional element according to the second embodiment;

Figure 7 is a part sectional side view of interconnected edge sections of constructional elements according to the second embodiment;

Figures 8A and 8B respectively show side views of a channel piece and an edge section of a constructional element in accordance with a third embodiment;

Figures 9A and 9B respectively show side views of a channel piece and an edge section of a constructional element according to a fourth embodiment;

Figure 10 shows a side view of, and illustrates a method of attachment for, a constructional element;

Figure 11 shows a perspective view of, and illustrates an alternative method of attachment for, a constructional element;

Figures 12A and 12B respectively show side views of a constructional element and a channel piece according to a fifth embodiment;

Figures 13 and 14 respectively show enlarged side views of a detail of the plank profile and of the channel piece according to the fifth embodiment;

Figure 15 shows an enlarged side view of the plank profile with the channel piece mounted thereto according to the fifth embodiment; and

Figures 16A and 16B respectively show side views of two adjacently mounted constructional elements and of a single constructional element according to a sixth embodiment.

DETAILED DESCRIPTION OF SPECIFIC EMBODIMENTS

Referring firstly to Figures 1 to 4, a first embodiment of a composite constructional element is illustrated. More particularly, Figure 1 illustrates a

plurality of constructional elements 1 interconnected to form cladding for fixing to the outside of a wall.

Each composite constructional element 1 comprises a plank profile 2 and a cladding material 3. The plank profile 2 can be formed from a number of suitable materials including plastics, fibre glass or carbon fibre, but in this embodiment, the plank profile 2 is formed from sheet steel, eg. galvanised steel for weather resistance. The cladding material 3 can be cement, concrete, fibre cement, fibre glass, cellulose, foamed polymeric material, ceramics or polystyrene, and is typically a cement based material. In this embodiment the cladding material 3 is glass reinforced cement. Glass reinforced cement is known for moulding and casting building panels and architectural details.

The folded plank profile 2 includes a first edge section 4, a second edge section 5 and a rear face 6, which together combine to form a mould for the cladding material 3. As can be seen, the cladding material 3 extends continuously between the opposed first 4 and second 5 edge sections, across the rear face 6, such that a composite constructional element 1 having an external unitary appearance is achieved.

The first edge section 4 includes an edge face 4a which projects frontwards with respect to the rear face 6 and acts to retain cladding material 3 at one edge of the constructional element 1. The first edge section 4 also includes an attachment formation in the form of a lip 4b which projects backwards from the rear face 6. The lip formation 4b is formed as a channel in the plank profile 2 which is filled with cladding material 3.

The lip 4b also acts as a retaining formation. Because of its dovetail cross sectional shape (which acts as a type of undercut or underhook) when the cladding material 3 is moulded into the lip 4b, it is retained attached to the plank profile 2.

The second edge section 5 includes an edge face 5a which projects frontwardly from the rear face 6 and acts to retain cladding material 3 at the opposed edge of the constructional element 1. The second edge section 5 also includes a second attachment portion in the form of a channel 5b which projects laterally beyond the second edge face 5a. The channel 5b extends backwards from the rear face 6 and is shaped to receive lip 4b of an adjacent constructional element 1. Located inwards from the second edge face 5a is a second retaining formation 5d, again formed as a dovetail shaped channel in the plank profile and which is filled with cladding material 3. Because of its shape, when the cladding material 3 is moulded into the second retaining formation 5d, it is again retained attached to the plank profile 2.

Because the two retaining formations 4b, 5d are located at or adjacent the edges of the plank profile 2, when the thermal expansion of the plank profile 2 and the cladding material 3 differs, then the plank profile 2 can bend slightly and become delaminated from the cladding material 3 at the centre, whilst being maintained attached by the retaining formations 4b, 5d. This prevents cracking of the cladding material 3 under extreme high or low temperature conditions and extends the life of the composite constructional element.

The rear face 6 also includes longitudinal ridge formations, 6b, 6c, which are formed as channels

projecting backwardly from the plane of the rear face 6. These channels 6b, 6c also become filled with cladding material 3 and serve to stiffen the constructional element 1.

In the embodiment of Figures 1 to 4, the entire plank profile 2 is formed from a single sheet of steel. In this embodiment, the plank profile 2 is formed by roll-forming. The process of roll-forming involves the feeding of a flat profile of light gauge steel through a roll-forming machine to provide a desired profile. This is a known technology for the purpose of making roof sheeting, wall studs etc.

Once the profile 2 is formed, the cladding material 3 is moulded into the plank profile such that it is bounded by the rear face 6 and the edge faces 4a, 5a. The cladding material 3 covers substantially an entire front face of the building element and forms a flat front surface. The only part of the front face of the constructional element which is not covered by the cladding material 3 is the edge section 5. However, when the constructional elements 1 are interconnected, the edge section 5 is substantially covered by an adjacent constructional element 1 as the lip 4b clips into channel 5b. A narrow portion 5c remains exposed, which may be reduced to a width of approximately 2-3mm and if desired may be covered by an appropriate joint compound.

The constructional element 1 can be formed by this method and supplied in standard lengths which can be readily cut to any required length. Because the rolled steel profile 2 acts as a mould for the cladding material 3, the method of manufacturing is simplified and does not require any separate moulding step, thus eliminating the

need for any separate moulds, and the associated storage, handling and cleaning of such.

To assemble the constructional elements 1 to form cladding or panelling on a wall, a first constructional element 1 is fixed to an upright in the form of a timber upright 8 by screws which are fixed through screw holes 7 which are located at the base of channel 5b. In the alternative, self-drilling screws, rivets, staples, or nails, may be used, in which case the screw holes 7 are not required.

Once a first constructional element 1 is fixed to the upright 8, a second constructional element 1 can be rapidly positioned by clipping lip 4b (in a type of snap-lock) into channel 5b of the first constructional element 1 which is fixed to the upright 8. The screws 7 are concealed by the overlying second constructional element 1. The second constructional element can then be screwed to the upright 8 and so on. The constructional elements 1 can also be fixed to a frame having a steel stud in a similar way.

The constructional elements 1 are particularly thin; in the embodiment shown they have a thickness of approximately 20mm. Thus, when used as cladding or panelling on a wall, the floor space of the room is not substantially reduced. The constructional elements 1 are also light and easy to handle, and require no specially adapted support structure but can be screwed to any conventional frame or wall.

The ends of the constructional elements 1 can be joined by means of a sealing element 10, which is preferably formed from a waterproof plastics material such as neoprene. The sealing element 10 can be provided

directly between the ends of constructional elements 1, as illustrated in Figures 2 and 4, or between the ends of constructional elements 1 and a joining member 11 as illustrated in Figures 1 and 3. The sealing element 10 may further comprise arms 10a (Figure 4) for snug location in respective recesses defined in the profile 2 next to the first 4 and second 5 edge sections.

The joining member 11 may be provided as a U-shaped channel, wherein constructional elements 1 abut each side with a sealing element 10 interposed therebetween. As shown in Figure 3, a cover member 12 can be clipped into the joining member 11, which is screwed to the frame or wall by screws 13. The joining member 11 and cover member 12 can provide an aesthetic join effect to a wall etc comprising the constructional elements.

Figures 1 and 2 also illustrate corner members 14 which can be screwed to a timber upright 8, each corner member having flanges 14a, 14b which abut the end of a respective constructional element 1 and can be fastened thereto. A sealing element 10 may also be provided between the ends of the constructional elements and the flanges 14a, 14b.

The corner members 14 and joining members 11 can also be manufactured from roll formed steel.

Figures 5 to 7 illustrate a second embodiment of a constructional element and like reference numerals have been used to indicate similar or like parts. Figure 5 illustrates a plank profile 2 without moulded cladding material 3, and Figure 6 is an exploded view showing the cladding material 3 separated from the plank profile 2 (for clarity).

As shown in Figures 5 and 6, the constructional element of the second embodiment has generally the same features as that of the first embodiment. The folded plank profile 2 includes a first edge section 4, a second edge section 5 and a rear face 6, which form a mould for the cladding material 3. As in the first embodiment, the first edge section 4 includes an edge face 4a which retains cladding material 3 at one edge of the constructional element 1, and the second edge section 5 includes an edge face 5a which acts to retain cladding material 3 at the opposed edge, and so that the cladding material can extend continuously between edge faces 4a and 5a.

An attachment portion in the form of a channel 5b projects laterally beyond the second edge face 5a, and a second retaining formation 5d is formed inwards from the edge face 5a. The second retaining formation 5d, as in the first embodiment, comprises a dovetail shaped channel in the plank profile.

The edge section 4 includes an attachment formation in the form of a lip 4b which is shaped for clipping engagement with a hook portion of channel 5b on an adjacent constructional element 1 in a kind of snap-lock (see Figure 7). The lip 4b is shaped to also act as a retaining formation due to its cross sectional profile which means that, once the cladding material 3 is moulded into the lip 4b, it is retained attached to the plank profile 2.

In the second embodiment, the lip 4b includes a recessed channel 4d on its underside. As illustrated in Figure 7, the recessed channel 4d accommodates the head of a fastening means such as a hex screw 20 when the constructional element is clipped to an adjacent

constructional element. The hex screw 20 is screwed through the base of channel 5b to attach the adjacent constructional element 1 to a support or upright. Thus the second embodiment allows the use of hex screws 20 for fastening the constructional elements to an upright, whereas the first embodiment typically requires the use of fasteners which are generally flush to the base of the channel 5b.

Figures 8 and 9 illustrate third and fourth embodiments in which, rather than the entire plank profile 2 being formed from a single sheet, the channel 5b is formed as a separate piece.

Figures 8a and 9a illustrate the separate piece comprising a channel 5b, an exposed section 5c and an L-shaped depending portion 5e. Figures 8b and 9b illustrate the channel section assembled with the remainder of the plank profile 2 to form a constructional element 1. The depending portion 5e extends over edge face 5a into retaining formation 5d. The L-shaped depending portion 5e is dimensioned such that one side 5e' has the same length as edge face 5a and, when assembled, abuts the edge face 5a. The other side 5e" of the L-shaped depending portion 5e has the same length as the base of retaining formation 5d and, when assembled, abuts the base of retaining formation 5d. Once the channel portion is assembled with the remainder of the plank profile, the cladding material can be moulded and will fill retaining formation 5d such that the depending portion 5e is embedded in the moulded cladding material 3, thereby fastening previously separate channel 5b to the constructional element 1.

One advantage in providing the channel portion as a separate piece is that it simplifies the roll forming

required to make the plank profile 2, and the separate channel portion piece can also be more easily formed. Also, the separate piece covers the cut edge of the plank profile 2, and can thus reduce corrosion.

Furthermore, different channel portions can be provided depending on the finish required. As shown in Figures 8a and 8b, the exposed section 5c can be minimised. However, the embodiment of Figure 9 provides the channel 5b as part of an "expressed" joint, allowing for interesting aesthetic effects to be achieved, For example, the larger exposed outer face of exposed section 5c can be coloured, painted or treated. It may also be manufactured from a different material such as brass or colour bonded steel to give an attractive finish to the exposed section 5c.

Figures 10 and 11 illustrate alternative means for attaching the constructional elements to a structure. Figure 10 shows a clip portion 30 which is screwed to a wall or upright be hex-headed screw 20 and which is shaped to engage with one of the retaining formations 4b, 5d (eg. in a kind of snap-lock). In Figure 11, a clip portion 30' is integrally formed as part of a c-section upright 31, thereby avoiding the requirement to attach a separate clip.

Figures 12 to 15 illustrate a fifth embodiment of a constructional element, and like reference numerals have been used to indicate similar or like parts.

Figure 12A illustrates a finished constructional element 1 including a plank profile 2', with moulded cladding material 3 extending continuously between the opposed edge sections 4 and 5. As also shown in Figures 13 and 15, the plank profile 2' has rounded lips 4b and 5d

and rounded ridge formations 6b. 6c. Thus, the retaining formations 4b and 5d are less sharply (dovetail) shaped than in previous embodiments.

As in the second embodiment, the first edge section 4 includes an edge face 4a which retains cladding material 3 at one edge of the constructional element 1. However, in the fifth embodiment the edge face 5a of second edge section 5 helps to retain cladding material 3 by enabling the mounting of a modified separate channel piece 5b' at edge face 5a, so that the cladding material can then extend continuously between edge face 4a and the channel piece (see especially Figures 12A and 15 in this regard).

Figures 12B and 14 show the modified separate channel piece 5b', again comprising an exposed section 5c and an L-shaped depending portion 5e. Figure 15 illustrates the channel piece 5b' assembled with the remainder of the plank profile 2' to enable formation of the constructional element 1. Again, the depending portion 5e extends over edge face 5a and into retaining formation 5d. However, in this embodiment side 5e' of the L-shaped portion does not have the same length as edge face 5a although it still abuts the edge face 5a when assembled (with the face 5a being sandwiched between exposed section 5c). Again, the other side 5e" of the L-shaped depending portion 5e has approximately the same length as the base of retaining formation 5d and, when assembled, abuts the base of retaining formation 5d. Again, the moulded cladding material 3 will fill retaining formation 5d such that the depending portion 5e is embedded in the cladding material 3, thereby fastening previously separate channel piece 5b' to the constructional element 1.

It will also be seen that the separate channel piece 5b' differs from that of Figures 8 and 9 in that, instead of a curled-over outer edge defining a hook formation, the channel outer edge is folded back onto itself to define land 5f, together with an upstanding lip formation 5g (shaped correspondingly to lip 4b). A hex-headed screw 20' can then be screwed through land 5f to fasten the constructional element to a frame member.

Again, once a first constructional element 1 is fixed to a frame member (eg. upright 8) by screw 20', a second constructional element 1 can be rapidly positioned by clipping lip 4b (in a type of snap-lock) under lip formation 5g. Again, screw 20' is concealed by the overlying second constructional element 1. The second constructional element can then be fixed to the frame member and so on.

Other than the differences outlined above, the constructional element of the fifth embodiment has generally the same other features as that of the second embodiment.

Figures 16A and 16B illustrate a sixth embodiment of a constructional element, and different reference numerals are now employed.

Figure 16B illustrates a finished constructional element 100 including a modified plank profile 102, but with moulded cladding material 103 still extending continuously between opposed edge sections 104 and 105. The plank profile 102 also comprises rounded ridge formations 106.

In this embodiment the plank profile 102 does not employ a lip 4b, and instead defines a rearwardly projecting ridge 107. That ridge defines first and second

undercut regions 107a, 107b which each act as retaining formations adjacent to edge section 104. The region 107a also enables the mounting together of adjacent constructional elements 100 as described below.

Furthermore, the plank profile 102 employs a slightly different second retaining formation to that of 5d. In this regard, whilst edge section 105 also defines a rearwardly projecting ridge 108 located at the edge section (with previous edge face 5a being replaced by an angled face 109), that face then continues on into a generally L-shaped channel 110. Channel 110 then has an upwardly protruding lip 111 defined at its free end.

A land portion 112 of the L-shaped channel 110 can receive a screw 120 (eg. a hex-headed screw) therethrough, to fasten the constructional element to a frame member. Again, once a first constructional element 100 has been fixed to the frame member by screw 120, a second constructional element 100' can be rapidly positioned adjacent to the first element 100 by locating ridge 107 under upwardly protruding lip 111. In this regard, as shown in Figure 16A, the lip 111 is received snugly into undercut region 107a (ie. this is a free-fitting and not a snap-lock mounting arrangement). Again, screw 120 is concealed by the overlying second constructional element 100'. The second constructional element 100' can then be fixed to the frame member and so on.

It has been found that the plank profiles of the embodiments of Figures 12 to 16 are particularly well shaped for easy roll forming, thereby reducing overall manufacturing costs. This is in part attributable to the smooth curves employed. Further, each of these plank profiles does not require the forming of a specific screw

rebate. In addition, each of these plank profiles allows for easy removal of planks for behind-plank access, constructional element replacement etc.

The plank profile of each of the constructional element embodiments described above in Figures 1 to 16, when formed of eg. galvanised steel, can provide a weatherproof membrane to any structure built using the constructional elements. The various clipping mechanisms described above also enable adjacent elements to be rapidly clipped together and in a concealed manner (ie. the elements are clipped together at their non-exposed undersides in use).

The composite construction allows less of each of the plank profile and cladding to be used, resulting in a lighter and thinner element, thereby improving installation. Because the constructional element may be as thin as 20mm, it can thus increase building floor area and not compromise eave overhangs or boundary setbacks.

The constructional element can easily be cut to length on site and does not require a purpose built superstructure (ie. it can be used with known framework) and may be attached to the superstructure using conventional fasteners.

A variety of surface finishes may also be applied to the cladding for aesthetic enhancement.

The constructional elements can be used in horizontal, vertical and angled formats. When used as a floor plank, they may be fabricated to be thicker to accommodate increased loading.

In the claims which follow and in the preceding description, except where the context requires otherwise due to express language or necessary implication, the word

"comprise" or variations such as "comprises" or "comprising" is used in an inclusive sense, i.e. to specify the presence of the stated features but not to preclude the presence or addition of further features in various embodiments.

It is also to be understood that a reference herein to a prior art publication does not constitute an admission that the publication forms a part of the common general knowledge in the art in Australia, or any other country.